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METHOD AND APPARATUS FOR THE PRILLING OF FERTILIZER

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The invention concerns a method for the "prilling" of simple or mixed fertilizer, which mainly contains ammonium nitrate and its compounds, such as 20.5%, 26%, and 33% N and a

mixture of ammonium sulfate and nitrate. Furthermore, the invention concerns an apparatus for the carrying out of this method in plants with prilling towers.

The "prilling" of fertilizers, such as ammonium nitrate and urea in prilling towers, can be carried out in different ways—using mouthpieces (nozzles), rotary baskets, and prilling disks.

The first two possibilities, in which the product is thrown into the tower with a circular movement, require very large dimensions, so that the product does not strike the tower walls, under the effect of the centrifugal force. With the last-mentioned method, smaller towers can be used, because the product exits vertically. Herein lies one advantage of this method, since lower costs are generated. However, the mode of operation of these towers with the last-mentioned method involves a large number of problems--essentially in connection with those plants which produce mixed fertilizer with a low nitrogen content (20.5% to 27% N -ammonium nitrate limestone and a mixture of ammonium sulfate and nitrate), wherein additional solid, finely distributed nutrients are included in the suspension to be prilled.

For example, the scatter openings of the prilling disk on the tower head tend to become clogged, wherein the plant has to be shut down, in order to wash and clean the scatter openings. Since, on the other hand, the supply vessel of the prilling disk is so large, it must be insulated and heated, in order to maintain the suspension in the best operating conditions for the prilling disk. Furthermore, the fertilizer tends to adhere to the side walls of the supply vessel, since the suspension is hurled against the walls by the movements of the stirrer. In this way, solid sludge agglomerates are formed within the vessel, which fall down and clog the scatter openings. Also the great height of 1 - 1.15 m (40-45") requires the use of a stirrer with a very long, cantilever shaft, which causes considerable mechanical problems and leads to a very low work output.

As is known, many attempts have been undertaken to improve the operating conditions of such plants. It has not been possible thereby to prolong the operating times of the plants and to avoid their shutdowns. The reason for the failure of these attempts lies in the fact that two or three vessels are located on the prilling tower head, wherein one or two of these vessels serve as replacement vessels, which are cleaned and maintained, while another one is in operation. However, the short operating time of each vessel--sometimes only a few hours--does not permit a continuous mode of operation.

Accordingly, the goal of the invention is to create an actually effective possibility for the prilling of simple or mixed fertilizer, wherein the work is done vertically. A continuous operation is to be made possible, in which, using a single supply vessel, a cleaning of the prilling disk or of the supply vessel is not required.

To attain this goal, the invention creates a method for the prilling of simple or mixed fertilizer in plants with prilling towers, which is characterized in that pure ammonium nitrate or a mixture of ammonium nitrate with other nutrients, such as ammonium sulfate or pulverized

limestone, in various combinations, with a water concentration, which can attain values below 0.5%, is prilled vertically.

In accordance with the invention, it is possible to use towers of smaller dimensions. Thus, a yield of approximately 400 tons/day (17 tons/day [sic; tons/h] in 20.5% N) is attained with a 5 x 5-m tower, which would be impossible with the same dimensions using rotary baskets and mouthpieces. A plant working in accordance with the invention, with a capacity of 300 tons/day, has already been in operation for a year and has not had to be shutdown a single time up to now because of the failure of the prilling apparatus--without it being necessary to exert any external effects, such as, perhaps, hammer blows or vibrating systems. Various fertilizers were thereby produced--from ammonium nitrate to ammonium nitrate limestone and a mixture of ammonium sulfate and nitrate.

Other advantages and features of the invention can be deduced from the following description of a preferred exemplified embodiment, in connection with the appended design. The figures of the design show the following:

Figure 1, a scheme of a plant, which delivers an increased output with operation in accordance with the invention;

Figure 2, a side view of the supply vessel located on the tower head;

Figure 3, a sketch of the supply vessel according to Figure 2;

Figure 4, a vertical section through the supply vessel according to Figure 2.

In accordance with Figure 1, a mixing vessel 4 is supplied, via a conduit 1, with an aqueous solution with 83% ammonium nitrate or another concentration. Through a conduit 2, finely pulverized limestone reaches the mixing vessel 4. Furthermore, a conduit 3 is provided, through which additional components, such as iron sulfate (discharged from the screen of the finished product) or ammonia, are added. The supply of the mixed vessel 4 takes place continuously and in adapted quantities, to obtain various nitrate types present on the market--from pure ammonium nitrate to the weakest fertilizers (20.5%). In order to attain a uniform and homogeneous and thorough mixture of the various components, the mixing vessel 4 is equipped with a stirrer. Furthermore, it is heated, so as to attain the correct operating temperature. The temperature of the mixture must be kept at values above the melting point of the ammonium nitrate, wherein one remains as close as possible to this temperature, so as to avoid reactions of the mixture.

It was found that the temperature is preferably between approximately 80° and approximately 150°C, wherein unburned limestone of such a particle size is used that 100% passes through a screen with 70 Tyler mesh.

The suspension coming from the mixing vessel 4 arrives at a pump 6 via a conduit 5 and from there to a filter 8 via a conduit 7. The filter 8 is used to remove nonuniform parts of the

suspension. From the filter 8, the suspension arrives at a film evaporator head 10 via a conduit 9. This works with a descending or sloping film, as is described, for example, in US-PS 2,089,945. A solution which contains a compound and a volatile liquid flows in counterflow to a heated inert gas as a continuous film over a heated surface. The latter is maintained at a temperature which lies above the melting point of the compound in an anhydrous state. The flow rate of the liquid is such that the film comes into contact with the surface only briefly, so as to avoid a decomposition of the compound. The contact time, however, is sufficient to dehydrate the suspension.

Since the suspension flows downward as a thin film, its water content is reduced, in stages, from the entry point into the evaporator head to the evaporator bottom, where an essentially anhydrous product is obtained. From the evaporator bottom, the suspension arrives at a supply vessel 12 of the prilling tower 13 via a conduit 11. The residence time of the suspension in the supply vessel 12 should be as short as possible, because the product leaves the bottom of the evaporator 10 with little water and has a temperature which is close to that of sludge solidification. The supply vessel 12 is equipped with a stirrer, so that the suspension goes through a prilling disk located on the bottom of the supply vessel 12. The supply vessel is concentric to the prilling tower 13, which is supplied with air, which enters in the vicinity of its bottom. The air migrates, in counterflow to the prill-shaped product, through the head of the prilling tower.

The prilling tower 13 has the shape of a quadrangular prism with a triangular, prism-shaped bottom. One of the edges between the base surfaces is open and supplies a conduit 14, which leads to a cooler 15. Here, the product is cooled, before it arrives at a screen 16 and subsequently at a coating drum 17. The product is conveyed to the storage building via the conduit 18. The geometric shape of the prilling tower is not a critical feature. Thus, the prilling tower can have a quadrangular, rectangular, or round cross-section.

In connection with Figures 2, 3, and 4, a few experiments should be explained, which were made so as to improve the mode of operation of the disks and the prilling. The first supply vessels were round, had a stirrer, and measured 800-1200 mm in height. Their diameters were between 650 and 750 nm. The prilling disk was fixed on the vessel bottom by a flange. In order to eliminate the cause for the defective mode of operation of these arrangements, different modification and improvement experiments were undertaken. Thus, for example, a hammer striking the prilling disk from below was used, which was changed later with a hammer striking from above, in order not to allow the sludge in the boreholes to solidify and to clog the prilling disk. Furthermore, the number (4, 6, and 8) of stirring blades and their angle of inclination was changed, so as to give the suspension at the entry of the prilling disk an appropriate and rapid movement. Also, a chamber was provided in the area of the stirring blades, which was bounded

below by the prilling disk and above by a perforated disk, so as to prevent sludge from being hurled against the vessel walls and in this way, from forming solid agglomerates which clogged the prilling disk. Another experiment consisted in providing a Teflon sleeve connected with the inner vessel walls by a crosspiece, so as to eliminate the mechanical deficiencies of the stirrer shaft, which were caused by its length. The prilling disk had between 3000 and 7000 boreholes with various diameters. If, on the other hand, no clogging occurs, and the product remains in the vessel only a short time, then this shaft can be designed much smaller and lower, wherein the mode of operation of the stirrer is improved and its mechanical deficiencies are eliminated.

The mode of operation of the stirring blades was similar to a sieving machine (passe-vite). The stirring blades forced the sludge to flow through the boreholes, wherein drops were formed on the outside of the boreholes, which covered the entire surface of the disk. Under the effect of the force of gravity, the drops fell, in counterflow to the air rising through the prilling tower, downward. The product obtained in this manner was very nonuniform and contained a large fraction of reject coarse grains and sometimes, such large agglomerates that they did not solidify over the entire height of the prilling tower. On the other hand, a few drops solidified before becoming detached from the prilling disk, so that the latter became clogged.

In accordance with the invention, on the other hand, the stirrer works as an impeller, similar to that of a centrifugal pump and throws the product through boreholes provided only on the circumference of the prilling disk--at a prespecified initial speed, which depends on the blade speed and on the air flow rising in the prilling tower. The adjustment of these variables--namely, blade speed, borehole diameter, and supply flow--thus makes possible a better quality control of the finished product with respect to the size and shape of the grains, because, namely, the dropping of the product is independent of its weight, its viscosity, and the higher or lower efficiency of the vibration system.

Since the stirrer-impeller exerts a pressure on the sludge on the entry into the boreholes, one can a) enlarge the borehole diameter; b) avoid clogging; c) produce smaller fine grains; d) increase the production capacity with the same output.

With the stirrers working in a manner similar to a sieving machine, the sludge which does not pass through the boreholes has a tendency to rise upwards on the vessel walls under the pressure effect of the blades. On the other hand, if one uses a stirrer-impeller, in accordance with the invention, which works in a low cylinder chamber supplied in the middle part of the blades with the sludge to be prilled, the sludge does not rise on the walls, since all the sludge is driven by the blades through the boreholes.

The apparatus in accordance with the invention, as it is represented in Figures 2, 3, and 4, therefore offers the possibility of attaining good results, without the disadvantages explained above appearing.

In accordance with the drawing, a truncated cone-shaped supply vessel 19 is provided, whose upper larger base 20 has a diameter of approximately 350 mm. The lower, smaller base 21 is open and connected with a chamber 22 for the stirring blades. This chamber has the shape of a cylinder with a height of approximately 50 mm and a diameter of approximately 600 mm. Its underside consists of a prilling disk 23, which is affixed to a flange. The entire arrangement is affixed, using flaps 24 on beams of the tower head and, as a whole, has a height of approximately 300 mm and a weight of approximately 110 kg. It is made of stainless steel and has metal supports for 25 reinforcement.

The suspension coming from the evaporator 10 enters laterally through an inlet 26 into the supply vessel. A stirrer shaft 27, screwed on the blade system, is located in the axis of the truncated cone. A stopper 28 is used to introduce ammonium to control the pH value of the suspension--in view of ammonium losses which occur in the evaporator 10. The prilling disk has around 300 boreholes, which have a diameter of approximately 2 mm and are located on the circumference.

The described arrangement has proven good in the production of any product, without having to undertake possible modifications. The quantity of the product produced is dependent on the speed of the impeller (impeller shaft coupled with an adjustable speed-range electric motor), on the level of product in the supply vessel, and on the diameter of the boreholes in the prilling disk. The changing of the prilling disk can be carried out extraordinarily quickly (about half an hour), since the entire arrangement can be handled very easily.

In order to clarify the efficiency of the method in accordance with the invention, the following table shows some examples from the production area of an industrial plant--determined in various seasons:

1 PRODUKT	2 GEMISCH			6 Stündlich-Herstellung	7 Gesamtes Harnstoff	8 KORNGROSSEANALYSE				
	3 Ammon Nitrat als 100%	4 Gebrochener Kalkstein	5 Ammon Sulfat			4 mm %	2,8-4 mm %	2-2,8 mm %	1-2 mm %	1 mm %
Ammonsulfat-salpeter 26% N 9	38%	-	62%	7 t	26,2%	0,5	30,1	35,0	29,2	5,2
Ammonsulfat-salpeter 30% N 9	65%	-	35%	4 t	30,2%	-	14,5	33,3	49,5	2,7
Nitrokalkstein 20,5% N 10	60%	40%	-	12 t	20,5%	0,2	10,8	30,0	56,4	2,6
Nitrokalkstein 26% N 10	76%	24%	-	10 t	26%	0	6,0	29,9	58,9	5,2
Ammonsalpeter 11 33,5% N	98%	2%	-	10 t	33,8%	0,2	10,9	34,5	49,1	5,3

12 Die Korngrösseanalyse betriff das zum Lagerhaus gesandten Produkt nach dieses zwischen 8-10% von verworfenen Grobkörnern und 10-12% von verworfenen Feinkörnern im Siebe gelassen hat welche in das Mischgefäss rückgeführt sind.

[Key to previous page:]

1 Product
2 Mixture
3 Ammonium nitrate as 100%
4 Broken limestone
5 Ammonium sulfate
6 Hourly production
7 Total urea
8 Particle size analysis
9 Mixture of ammonium nitrate and sulfate
10 Nitro-limestone
11 Ammonium nitrate
12 The particle size analysis concerns the product sent to the storage building after it has left between 8-10% rejected coarse grains and 10-12% rejected fine grains in screens, which are returned to the mixing vessel.

Claims

1. Method for the prilling of simple or mixed fertilizer in plants with prilling towers, characterized in that pure ammonium nitrate or a mixture of ammonium nitrate with other nutrients, such as ammonium sulfate or pulverized limestone, in various combinations, with a water concentration which can reach values below 0.5%, is prilled vertically.

2. Method according to Claim 1, characterized in that a truncated cone-shaped supply vessel is connected to a cylindrical chamber with its smaller base.

3. Method according to Claims 1 or 2, characterized in that the suspension to be prilled enters the cylindrical chamber via the supply vessel.

4. Method according to one of Claims 1 - 3, characterized in that the suspension to be prilled is thoroughly stirred by a stirrer, whose blades rotate within the cylindrical chamber.

5. Method according to one of Claims 1 - 4, characterized in that the bottom of the cylindrical chamber consists of a disk, whose boreholes are located in two concentric circles on the circumference.

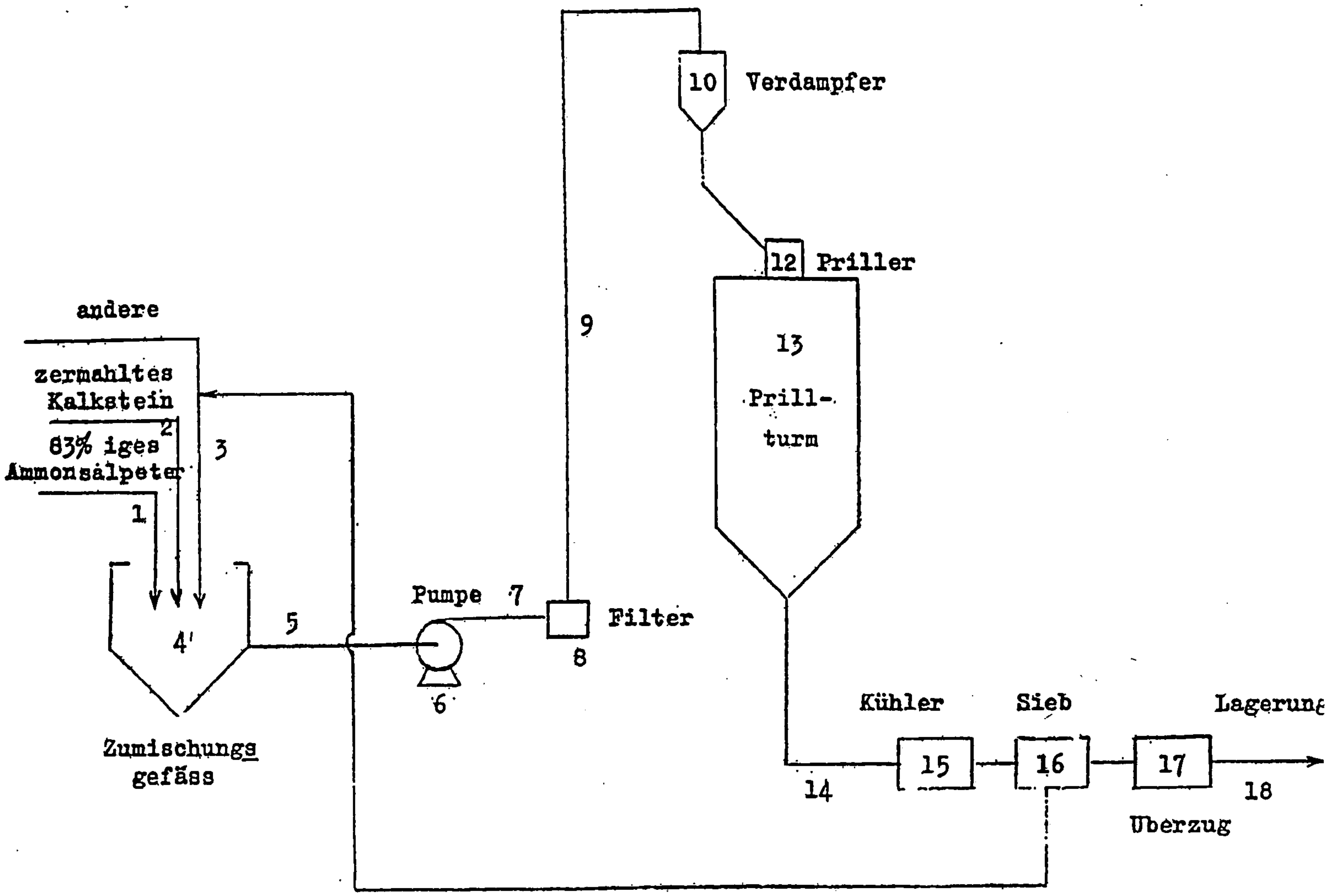
6. Method according to one of Claims 1 - 5, characterized in that the stirrer works as an impeller.

7. Method according to one of Claims 1 - 6, characterized in that the suspension is kept at a prespecified pressure by speed regulation of the blades of the stirrer-impeller.

8. Method according to one of Claims 1 - 7, characterized in that the blade plane is inclined at an angle to the horizontal, in order to maintain a prespecified suspension pressure at the entry into the prilling disk, which is adapted to the production conditions resulting from the system.

9. Method according to one of Claims 1 - 8, characterized in that the suspension to be prilled contains ammonium nitrate.

10. Method according to one of Claims 1 - 9, characterized in that the suspension consists of ammonium nitrate with one or more solid and finely distributed nutrients.



10
Verdampfer
12
Priller
9
13
Prill-
turm
andere
zermahltes
Kalkstein
2
83% iges
Ammonsalpeter
3
1
4'
5
Pumpe
7
Filter
8
6
Zumischungs
gefäss
Kühler
Sieb
15
16
17
14
18
Lagerung
Überzug

Figure 1

Key:
1 83% Ammonium nitrate
2 Pulverized limestone
3 Other
4 Admixture vessel
6 Pump
10 Evaporator
12 Priller
13 Prilling tower
15 Cooler
16 Screen
17 Coating
18 Storage

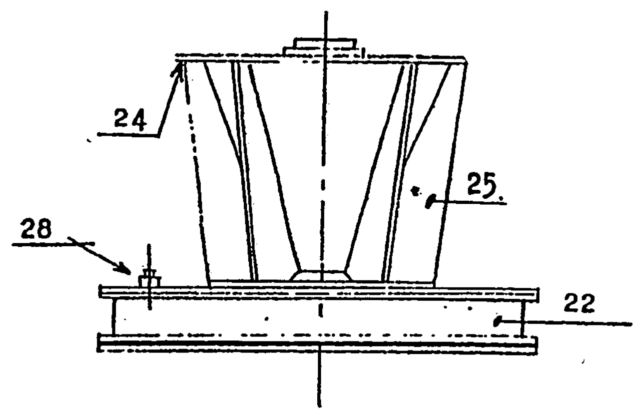


Figure 2

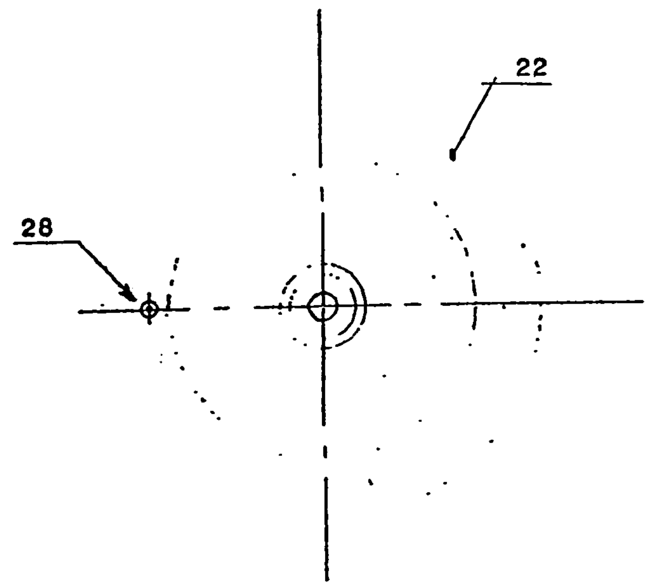


Figure 3

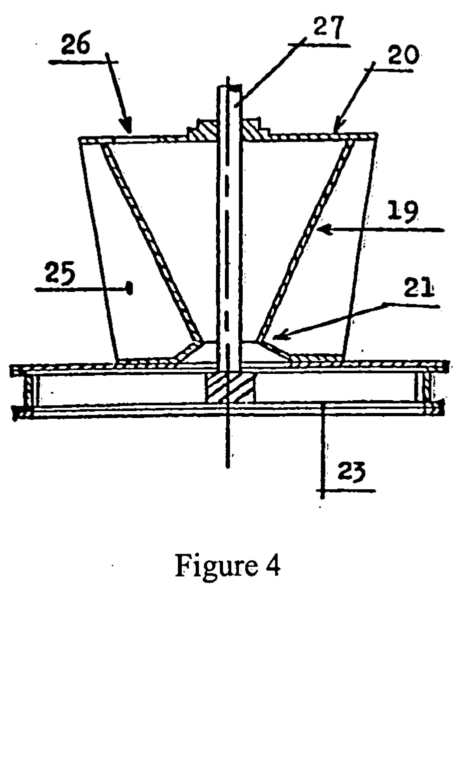


Figure 4